Saskatchewan Agriculture, Food and Rural Revitalization

FARM Facts

Crops for silage production

Silage can be successfully made from any green crop that has sufficient water-soluble carbohydrates and appropriate moisture content. Storing of these crops as silage provides a number of benefits. Silage is harvested at a relatively high moisture content and is wilted in the field for short periods of time, reducing field losses compared to hay production. Nearly all crops have been and can be used as silage. In Saskatchewan, cereals are the most common crops used for silage.

Annual Crops for Silage

Agronomic practices such as fertilizer and weed control for producing annual crops for silage should be directed to optimizing total dry matter yield. Quality comparisons of commonly used annuals are listed in **Tables 1.**

Cereal Silage

As water-soluble carbohydrate levels are high, buffering capacity is relatively low and moisture content is easily controlled, cereals are easily ensiled. Cereals should be harvested for silage before they complete maturity, as quality, especially protein content, is relatively low. The maximum total energy and protein yield is obtained by harvesting at or before the hard dough stage, depending on the species. For example, triticale should be cut shortly after flowering. Moisture content is approximately 70 per cent at this stage. After a wilting period, the crop should be ensiled at 65 per cent moisture.

To lengthen the harvest period, it is usually better to use high yielding varieties or species with varying maturity dates, rather than delaying seeding with one variety. The use of one variety seeded at various dates usually results in lower overall yields.

Silage crops are field wilted prior to chopping.

If feeding requirements indicate a need for higher protein than that provided by cereals in the mid-dough stage, consideration should be given to purchase a protein concentrate. Harvesting early will reduce dry matter yield, so the economics of using higher quality crops, versus cutting later and providing protein supplements, should be considered.

Table 1. Average nutrient content of silages (%)

Crop	Crude protein	Estimated energy TDN	Calcium	Phosphorous	ADF	NDF
Barley	14.1	53.0	0.46	0.32	37.7	56.7
Wheat	12.5	57.8	0.30	0.27	39.8	58.4
Oats	12.5	49.0	0.37	0.26	38.7	58.5
Alfalfa	26.1	58.6	1.54	0.24	26.1	33.5
Clover	16.2	58.1	1.28	0.22	36.1	43.6
Corn						

Source – University of Saskatchewan, and Saskatchewan Agriculture, Food and Rural Revitalization

Barley

Barley is a relatively high yielding crop under dryland production in the Brown, Dark Brown, and Black soil zones in Saskatchewan, and is a high yielder under irrigation. In the Black soil zone, barley has similar dry matter yield to oats.

Barley silage is higher in quality than other cereals and this can compensate for slightly lower yields in locations where other cereals may have greater yield. Barley is very responsive to intensive production and will give higher yields with increased fertilizer rates. It is also used to some extent in the Grey soil zone, but lower yield and lack of adaptability to conditions such as acidity and excessive soil moisture limit its usefulness in some places. Barley is less tolerant of acid soils than oats.

Barley is earlier maturing than other cereals and may be planted in May to early June in northern areas. When grown for silage production, both two-row and six-row barley varieties should be seeded at 85-130 kg/ha (75-120 lb/ac). Higher seeding rates are used with higher soil moisture conditions.

High rates of fertilizer, especially nitrogen, are required for high silage yields. Fertilizer rates of up to 140 lb/ac (185 kg/ha) of nitrogen have been applied to barley silage fields. Often high nitrogen applications accentuates varietal yield differences.

Barley has less lodging resistance than other cereals, except oats, and the use of high rates of nitrogen fertilizer increases this problem. There are varietal differences in lodging resistance. Smooth-awned varieties are more satisfactory for silage making.

Since barley is an early maturing crop with some drought tolerance, it has low water requirements.

In irrigated areas, maximum silage yields can be obtained with a total of 375-450 mm (15-16 in.) of water.

Table 2. Cereal dry matter forage yields, Saskatoon, SK (kg/ha)

Crop	1999	2000	2001	Mean
Barley				
AC Rosser	7069	7283	3150	5834
Virden	7239	7081	3357	5892
AC Lacombe	7508	7320	3016	5948
CDC Earl	6910	5978	3374	5421
CDC Dolly	7768	6730	2994	5831
Bonanza	7845	6835	2784	5822
Manley	7399	7016	2762	5726
Seebe	6964	7001	3132	5699
Barley mean	7337	6905	3071	5771
Oats				
CDC Bell	8288	7088	2297	5891
CDC Pacer	7755	7358	2491	5868
AC Mustang	7934	6905	2283	5707
Oat mean	7992	7117	2357	5822
Triticale				
Frank	8576	-	2198	5387
Wheat				
CDC Teal	7755	-	2088	4922
Genesis	8116	-	2116	5116
Wheat mean	7935	-	2062	5019

Source: Saskatchewan Forage Council

Table 3. Cereal dry matter forage yields, Canora, SK (kg/ha) 1998-2000

Crop	1998	1999	2000	mean
Barley				
AC Rosser	7547	12955	10906	10469
Virden	7479	13757	9922	10386
AC Lacombe	7690	14159	8529	10126
CDC Earl	7240	12781	10301	10107
CDC Dolly	7212	11343	10072	9542
Bonanza	6617	13148	8551	9439
Manley	7815	10095	10307	9406
Seebe	7369	11348	9181	9299
Barley mean	7371	12453	9721	9846
Oats				
CDC Bell	8448	9998	10825	9757
CDC Pacer	6865	9937	9649	8817
AC Mustang	7461	8201	9771	8478
Oat mean	7591	9378	10081	9017
Triticale				
Frank	6937	7926	7316	7393
Wheat				
CDC Teal	6181	6939	7981	7034
Genesis	7109	6257	7598	6988
Wheat mean	6645	6598	7789	7011

Source:Saskatchewan Forage Council

Table 4. Cereal forage yields, Melfort, SK (kg/ha), 1998-2000

Crop	1998	1999	2000	Mean
Barley				
AC Rosser	9869	13379	9741	10996
Virden	8297	12168	7893	9453
AC Lacombe	9331	12411	10695	10812
CDC Earl	10294	12897	8831	10674
CDC Dolly	12021	12076	9959	11352
Bonanza	11252	13864	7937	11018
Manley	9259	12326	8194	9926
Seebe	8097	10443	8766	9102
Barley mean	9802	12445	9002	10541
Oats				
CDC Bell	8269	14312	10998	11193
CDC Pacer	8744	15461	11218	11808
AC Mustang	9980	14341	12135	12152
CDC Baler	8447	14659	8860	10655
Oat mean	8860	14693	10802	11452
Triticale				
Frank	8657	14409	8090	10385
Wheat				
CDC Teal	10213	15034	12342	12530
Genesis	8752	13592	11333	11226
Wheat mean	9482	14313	11837	11878

Source-Saskatchewan Forage Council

Table 5. Nutrient content of cereal silage and stage of maturity

Species/stage	Drymatter (%)	Protein (%)	TDN (%)
Barley - early-dough	27	10	67
- mid-dough	33	9	68
- late-dough	37	10	70
Oats - early-dough	36	8	67
- mid-dough	38	7	61
- late-dough	41	6	57
Wheat - early-dough	36	10	61
- mid-dough	38	10	68
- late-dough	42	8	66

Moisture stress at the time of tiller initiation and development will reduce yield. Water requirements are highest from the shot blade stage to the time of kernel formation.

When using horizontal silos, swathing should be completed by the time the standing crop drops to 65 per cent moisture, since some moisture is lost during harvest. In barley, 65 per cent moisture occurs about three weeks after heading, i.e., at the early to mid-dough stage (**Table 5**).

Higher protein content in barley silage can be obtained at the expense of yield by harvesting earlier. Research indicates that the highest protein content is attained from the boot-to-head-emerged-stage but yields are approximately one-half those at the dough stage. Protein yields in barley and other silage can be increased by seeding legumes such as peas with the cereal.

Oats

Oats have the highest total dry matter and total energy yield of all cereals in the Grey soil zone. Oats are recommended for silage production on Dark Brown soils but are lower yielding than some other cereals.

Compared with other cereals, oats are more tolerant of acid soils and excessive soil moisture, but are less tolerant of salinity than barley or wheat. Oats are also intolerant of low soil manganese conditions associated with grey speck, a physiological disease. Manganese deficiency is often associated with poorly drained, high organic matter soils (i.e. cold soils) and sandy soils.

A number of oat varieties have been specifically developed for forage production. Lodging is a frequent problem when oats are grown under high soil nitrogen conditions and when soil moisture levels are high. There are differences in lodging resistance and in days to maturity between varieties.

Recommended seeding rates for oats for silage production range from 74-130 kg/ha (65 to 115 lb/ac). Higher seeding rates result in less tillering, finer stems and decreased plant height. Lower seeding rates are advantageous under dry conditions. Seeding rate does not have a significant effect on silage quality.

The moisture content of oats drops to 65 per cent at the late milk stage (approximately three

weeks after heading). At the late-milk stage, oats had produced about 85 per cent of maximum total yield. Although maximum total yield is reached at the early dough stage, delaying harvest until this time results in greater nutrient and storage losses from reduced packing efficiency when using horizontal silos. Energy levels are high in early growth stages but gradually decline with maturity and stabilize when the grain begins to develop.

The per cent digestibility of oats at recommended ensiling stages is slightly lower than barley or wheat. When comparing total dry matter yields from oats to other silage crops, the lower digestibility of oats should be considered and compared with alternative crops.

The protein content of oats is lower than that of wheat or barley. Crude protein does not usually drop below approximately nine per cent, since the developing seed contributes to protein content from the milk stage onwards. Total amount of protein per hectare increases until the dough stage, but maximum energy or digestibility of the whole oat plant is maximized at the milk stage.

Triticale

Although slightly lower yielding than barley, triticale yields well in the Dark Brown soil zone, particularly under irrigation. Triticale's tall growth habit is an advantage under dryland conditions. Triticale should be planted at a seeding rate of approximately 85-150 lb/ac (95-168 kg/ha) for silage production.

The main advantages of triticale include superior lodging resistance and late maturity. The moisture content of triticale is 65 per cent at the watery dough stage (four weeks after heading). However, peak digestibility and energy is reached shortly after flowering and early milk stage. Maturity, like in rye, is rapid, leaving only a narrow window in which to harvest. The protein content of triticale is intermediate between oats and barley.

Wheat

Although not commonly used for silage, **spring wheat** is a satisfactory crop for this purpose and is an optimal means to salvage hail-damaged crops. Wheat yields well in the Brown soil zone, especially under irrigation, but is usually out-yielded by barley or oats in other soil zones. Wheat is intermediate between oats and barley for tolerance to salinity and acidity. Wheat tolerates about 7 mmhos/cm salinity (a measurement of soil salinity determined by the soil's electrical conductivity), compared with 8 mmhos/cm for barley, and a pH of 5.5, compared with 4.5 for oats.

Wheat should be planted from mid to late May at a seeding rate of 85-125 kg/ha (75-110 lb/ac). Utility wheat varieties are most often used for silage, but hard red spring wheat varieties are better adapted to severe drought. Soft white wheat has yielded well for silage under irrigation.

Nutrient quality of wheat silage is comparable with the best of the other cereals. Wheat should be harvested in the early to mid-dough stage.

Prompt, efficient ensiling is necessary to reduce losses and preserve nutrient value of any silage crop.

Spring-seeded **winter wheat** gives low silage yields and requires at least two cuttings. Mixing winter wheat with another cereal may have benefits when the regrowth is used as pasture. Data collected at Brooks, Alberta indicate barley plus winter wheat yielded 94 per cent as much silage as barley alone, but in addition it produced two simulated pasture clippings which gave a total of 20 per cent more yield.

Fall-seeded winter wheat has a growth habit similar to that of spring seeded cereals. However, yield is somewhat less and more variable than for other cereals because of winter kill. It is therefore less reliable as a silage crop. Its early maturity can extend the silage harvesting season.

Spring Rye

Spring rye is adapted to the Brown and Dark Brown soil zones, especially under irrigation. In these areas, rye yields are more or less comparable to those of other cereals. Crop height is somewhat greater and this may be an advantage under dry conditions. Spring rye should be planted from mid to late May at 96-160 kg/ha (85-140 lb/ac) when grown for silage. Quality can be comparable with that of other cereals if harvested at the flowering to early milk stage.

Fall Rye

Fall rye yields well in all soil zones. It is very winter hardy and has the advantage of using spring moisture to promote early growth, a particularly useful trait on sandy soils that have low water holding capabilities and in areas of lower rainfall. Fall rye is capable of producing an early crop of silage and lengthening the silage-making season.

Fall rye should be seeded August 1 – September 15. Seeding dates should be earlier in northern areas. Recommended seeding rate is 63-127 kg/ha (56-112 lb/ac). Fall rye tillers profusely when adequate soil moisture and nutrients are present. Grazing of fall rye stands will reduce subsequent silage yields.

Fall rye for silage is ready two to four weeks earlier than most cereal silages. It should be cut at the end of flowering to early-milk stage. If allowed to mature, ergot bodies may form. Ergot bodies can cause abortions in livestock.

Silage quality of fall rye is comparable to that of other cereal crop silage, if harvested at the right stage. Total dry matter yields of fall rye are generally lower than those of oats but, in some cases, are greater than barley.

Pulse Crops

Peas

Peas are recommended for silage production in Grey and Black soil zones, and in irrigated areas. Peas are efficient users of water, however, they are not heat tolerant during flowering. High temperatures during flowering can lead to flower abortion and consequently reduce pod formation – an important yield component in pea silage.

Peas are best adapted to loam, clay loam and sandy loam soils. Soils with poor internal drainage or cold soils (e.g., organic soils) are not well suited to pea production since seedling and root diseases are more prevalent under these conditions. Peas have low tolerance to soil salinity.

Peas should not be grown on land cropped to peas in the past four years, owing to the increased risk of soil-borne diseases. Peas are most suitable following cereals in crop rotations.

Peas generally yield less total dry matter and digestible energy than cereals alone. The advantage of peas is that they yield a higher percentage of protein and total protein per acre than cereals.

Studies have indicated that the protein content of barley-pea silage can be 3.5 per cent greater than protein content of barley silage alone. This factor should be balanced against lower energy and possibly yield in mixed silage.

Peas should be seeded as early as possible when the average soil temperature at seeding depth has reached 4-5°C. Normal-leafed, long-vined pea varieties are recommended. Semi-leafless pea varieties are not recommended for silage production as they produce significantly less biomass than normal leafed varieties.

Pea seedlings have good frost tolerance and can regrow from buds below the soil surface if the main shoot is killed by severe

frost. Early seeding helps to achieve flowering before mid July, thereby avoiding heat damage to flowers.

A seeding depth of 5 to 7.5 cm. (2-3 in.) is recommended. Adjust seeding equipment to avoid cracking or chipping of seed. Slow travel speeds while seeding will decrease seed damage and help to maintain uniform seeding depth. Using small-seeded varieties reduces seed costs. A seeding rate of one seed per 7.5 cm (3 in.) with 15 cm (6 in.) row spacings is recommended - about 182-228 kg/ha (160-200 lb/ac) for large seeded varieties and 125 kg/ha (110 lb/ac) for small seeded varieties.

Seed should be treated with recommended fungicides to control fungal diseases. *Rhizobium* inoculant suitable for pea should be applied to the seed or the soil at the time of seeding to ensure optimum nitrogen fixation. Soil tests should be used to determine phosphorus and other fertilizer requirements. The use of starter nitrogen fertilizer is not recommended in most conditions.

Since peas are poor competitors, they yield best in pure stands. They lodge readily so swathing is difficult. Low cutter bar heights, lifter guards and pick up reels must be used.

Pure peas are difficult to ensile since water- soluble carbohydrate levels are low, buffering capacity is high and moisture content is high. Before ensiling, the crop should be wilted to 65 per cent moisture. Peas should be harvested when the earliest pods begin to wilt and wrinkle but before shattering occurs.

Growing a cereal-pea mixture can be effective in providing improved quality as compared with cereals alone and improving silage yield compared with peas alone. For mixtures, the cereal seeding rate should be reduced to 35 kg/ha (30 lb/ac) for oats or barley and about 57 kg/ha (50 lb/ac) for wheat or triticale. The cereal should be cross-seeded. Seeding rate on peas in mixtures should be ¾ of the pea monoculture rate and ½ the cereal monoculture rate.

Fababeans

Fababeans are upright-growing annual legumes that are resistant to lodging and very sensitive to drought. This crop can be used for silage production in the Black and Grey soil zones and under irrigation. A fababean crop for silage requires about 580 mm (23 in.) of water for good yields.

Fababeans produce less dry matter than most other crops, including peas, but have greater protein content than cereals. Fababeans have greater production costs (particularly seed costs) and are harder to ensile than cereals, due to high moisture content, low percentage of water soluble carbohydrates, and high buffering capacity.

For best yields, fababeans should be planted as early as possible in northern and central regions, and by mid-May in irrigated areas. Fababean seedlings are fairly frost tolerant. Fababeans are poor competitors, so weed control is important for good yields. A seeding depth of 7-10 cm (3-4 in.) and seeding rate of 170 kg/ha (150 lb/ac) is recommended for medium sized varieties, and 200 kg/ha (180 lb/ac) for large-seeded varieties is recommended.

Slow ground speeds when seeding avoids formation of hairline cracks on seed, and subsequent decreased germination and seedling vigor. Inoculate seed with viable fababean inoculant strain Q and a sticking agent just prior to seeding to ensure optimum nodulation and nitrogen fixation.

Fababean rhizobia are noted for high nitrogen fixation. Phosphorus and other nutrient requirements should be determined by soil testing.

Planting fababeans with a cereal for silage production is recommended. Cereal seeding rates in mixtures should be reduced to less than half the normal amount, while the fababean seeding rate should be 113 kg/ha (100 lb/ac) or more. Cross seeding the two species reduces competition between the two and increases fababean yields.

Fababeans should be swathed when one or two of the bottom pods on one-quarter to one-third of the crop have turned brown, the stage at which maximum

yield of energy and protein occurs. Wilting is still very necessary at this stage. Fababean silage is very dark in color but is readily eaten by livestock.

Corn

Corn is a warm season crop and has a higher optimal growing temperature than cereals commonly grown in Saskatchewan. Under conditions of adequate moisture and heat, corn has the greatest potential silage yields, compared to other commonly grown crops.

The growth and development of corn increases rapidly from an air temperature of 10°C up to 30°C (50°F - 85°F). As silage corn is harvested before the mature grain stage, varieties that require more heat units to mature than the growing area receives can be successfully grown.

Saskatchewan Accumulated Corn Heat Units
90% Confidence for Grain Production

Note: Local topography, soil type and surrounding vegetation can significantly alter microclimates. The daily CHU's were calculated by the following equation:
CHU = [1.8(Tmin-4.4) + 3.3(Tmax-10) – 0.084(Tmax-10)²] / 2
The seasonal CHU was calculated by a sum of all the daily CHU from May 15 until the first -3°C frost. Data from 1980-2000 was used. The 9/10 CHU is the third lowest seasonal CHU.
For further information, contact Kevin Olfert, 306-787-5041.
Legend
Weather Station
Corn Heat Units
1,400 - 1,799
1,800 - 1,899
1,900 - 1,999
2,000 - 2,099
2,100 - 2,199
2,200 - 2,299
Lloydminster
Prince Albert
North Battleford
Melfort
Saskatoon
Humboldt
Yorkton
Melville
Regina
Moose Jaw
Swift Current
Weyburn

Prepared from Environment Canada and Saskatchewan Agriculture, Food and Rural Revitalization's (SAFRR) Crop Development Branch data by the SAFRR Geomatics Unit.

For successful silage production, corn should be harvested prior to the first frost and contain 70 per cent moisture. At 75 per cent moisture, a hard frost can cause corn to lodge. Corn that has received a frost should be harvested as soon as possible to avoid loss of quality.

Consult with local seed dealers to select the variety best suited to local growing conditions.

Corn requires well drained soils for best production. Fine textured soils require good internal and surface drainage for satisfactory production. Corn is not tolerant of saline soils.

Field preparation should be completed to obtain a moist, firm, weed-free seedbed. Corn for silage should be planted in late April to the first week of May. Soil temperature for germination must be at least 10°C. Early cultivation, avoiding excess trash on the soil surface and good soil moisture levels help to make early planting possible.

Corn for silage should be precision seeded at 32,000 plants per acre (75,000 per ha) for irrigation, i.e., one seed per six inches. (15 cm) at 30 in. (75 cm) row spacings, assuming 85 per cent survival. Optimum seeding depth is two inches (five cm).

Although air drills and other seeding implements have been used successfully to plant corn, a corn planter is recommended. The use of a 30 in. row space accommodates standard corn harvesting machinery.

Fertilizer application should be done on the basis of a comprehensive soil test. Nitrogen application rates of 80 to 150 lb/ac (90-165 kg/ha) will be required under irrigation to optimize yields. Applications of phosphorus and potassium may also be required.

Granular fertilizer, especially phosphorus, is taken up by seedlings best if it is placed near

the seed. Placing nitrogen fertilizer one inch to the side and preferably slightly deeper than the seed permits high application rates (up to 270 lb/ac or 300 kg/ha) without serious injury to the emerging seedling.

Corn is not competitive with weeds, and careful control of weeds is mandatory for successful corn production. Chemical weed control options are provided in the *Guide to Crop Protection.*

Corn requires about 20 inches of water per year. Corn, especially for silage, requires good soil moisture levels throughout the growing season. Moisture stored from the previous year plus winter and spring precipitation usually provides enough water until mid June. The water requirements of corn are high from mid July to early September and irrigation is most necessary at that time. The most critical time for moisture is during the tasselling to grain filling stages. Since corn is tall growing, either a centre pivot or surface irrigation must be used.

For maximum energy yield per acre, corn should be harvested when the whole plant moisture content is 60-70 per cent. The 60-70 per cent moisture stage coincides with the hard dough stage. A corn silage harvester is required to harvest the tall-row crop.

Corn contains enough water-soluble carbohydrates to ensure successful ensiling although levels do drop in more advanced stages (see Table 4). It has a low buffering capacity so that less acid is required to lower the pH of the ensiled material (see Table 5). Corn silage has high energy levels but is fairly low (6-10 per cent) in crude protein.

Corn has high yield potential under favourable growing conditions.

Corn can be grown continuously provided that weeds, insects and diseases do not become a problem and fertility levels are kept high. Harvesting corn silage leaves very little crop residue, and erosion risks should be considered when managing corn fields.

Corn has high silage yield potential, however, the economics of corn production should be assessed very carefully, as it requires specialized equipment, higher inputs and more favorable growing conditions compared to other silage crops. Attempting to produce corn silage, in areas that are too cool on average, is likely to result in uneconomical production compared with growing cool season crops.

Warm-Season, Small-Seeded Grains

There are a number of small-seeded, warm-season grasses that can be used for silage production, including: sorghum, sudangrass, sorghum-sudangrass hybrids, and millets. Sorghum-sudangrass and millets are most frequently used in Saskatchewan, and are sometimes grown when dry conditions are anticipated.

Sorghum-sudangrass is a robust plant with coarse leaves and stems. Appearance is somewhat variable, depending on the parental lines used to develop the hybrid. Sorgum-sudangrass can regrow after cutting, if growing conditions are favorable.

Millets consist of a number of types, including proso and German (or foxtail millet). Millets are generally finer-stemmed than sorghum-sudangrass. Depending on the type of millet, modest or no regrowth occurs after cutting.

Most of these crops require 60 to 90 days of frost-free weather to produce a forage crop. Considerable variation is present amoung varieties, so complete information about the cultivar should be obtained prior to purchasing seed.

These crops are intolerant of wet or cold soils, so seeding should occur when soil temperatures reach 18 C (65 F), which usually occurs in early June. The seedbed should be firm and moist to encourage rapid establishment, as these crops are poor competitors with weeds. Seeding depth should be at depths of 1.5-5cm (1/2 to 2 inches), depending on soil texture and moisture.

Table 6 provides a guideline for seeding rates. If wide row spacings are being used, the crop should be seeded crossways or diagonally to the planned direction of swathing, in order for the swath to remain on the top of the stubble.

For silage production, sorghum-sudangrass should be cut in the dough stage with a mower-conditioner to encourage prompt wilting (60-70 per cent). Sorghum-sudangrass silage characteristically has an average protein content of 11.5 per cent (range of 7.7 to 16.4 per cent). TDN averages 51 per cent (range of 49 to 55 per cent).

Sorghum-sudangrass can potentially have high concentrations of cyanogenic glucosides. These compounds can break down into prussic acid (hydrocyanic acid) in the rumen, which can potentially result in respiratory paralyses and death. In order to reduce the risk of prussic acid toxicity, delay the feeding of sorghum-sudangrass silage until six to eight weeks after ensiling.

As with other annual forages, sorghum-sudangrass can accumulate nitrates to toxic levels. When in doubt, feed can be tested for both prussic acid and nitrates.

Table 6. Seeding rate, kg/ha (lb/ac) guidelines for sorghum and sudangrass varieties, hybrids, and crosses.

Crop type and row spacing	Dryland	Irrigation
Sudangrass varieties and hybrids, sorghum-sudangrass crosses -15-17.5 cm (6-7 in.) row spacing	17-28 (15-25)	34 (30)
Forage sorghum varieties, hybrids and crosses -75cm (30in.) row spacing	6-9 (5–8)	11-14 (10-12)
Forage sorghum varieties, hybrids and crosses -90-105 cm (36-42 in.) row spacing	6-9 (5-8)	9-11 (8-10)

Perennial grasses

Various perennial tame grasses are adapted to western Canada. The most widely grown tame grasses include smooth bromegrass and crested wheatgrass. Grasses ensile well, due to low buffering capacity and high dry matter content. Water-soluble carbohydrates vary among species, but is adequate for effective ensiling in most cases. Grasses are medium in quality (protein and energy) in early growth stages, but quality drops rapidly as they mature. Care should be taken to avoid harvesting perennial grasses at too mature a stage, as moisture contents drop below what is required for efficient ensiling. Shorter chop length, extra packing, or mixing with higher moisture feeds may be required to successfully ensile mature grasses.

Overall crop management of grasses for silage is similar to that for hay production. Additional production information can be found in the *Saskatchewan Forage Crop Production Guide*.

Perennial and biennial legumes

Legume crops are very high in protein, low in water soluble carbohydrates and high in buffering capacity. High buffering capacity can make ensiling difficult. Swathing and wilting are necessary to reduce the moisture content of legumes before ensiling.

The use of grass-legume mixtures improves the fermentation process, although it also results in lower protein and energy levels in the feed. Legume crop management for silage production is similar to that for hay production. Additional production information on these and other legume crops may be found in the *Saskatchewan Forage Crop Production Guide.*

Alfalfa

Alfalfa is broadly adapted and can be produced in all soil zones of Saskatchewan. It requires good internal soil drainage and is intolerant of acidity (i.e., intolerant of pH below about 6.0). Alfalfa has high yield and quality potential. Alfalfa cut when 10 per cent of the plants show first bloom will have a crude protein content of approximately 17-19 per cent. Alfalfa is not as difficult to ensile as most other legumes, due to it's greater dry matter content.

Sweet-clover

Sweet-clover is a biennial legume which is adapted to all soil zones of Saskatchewan. It requires good internal soil drainage and is intolerant of acidity (pH below about 6.0). Sweet-clover is very high yielding and ensiling is an excellent way to harvest this crop. Sweet-clover weevils are a problem where sweet-clover is grown frequently.

Sweet-clover should be harvested when 10-20 per cent of the plants show first bloom, if left until full bloom, sweet-clover becomes very stemmy and much lower in quality. Ensiling sweet-clover is similar to ensiling alfalfa. The resulting silage is more palatable than sweet-clover hay. Low coumarin varieties should be used to reduce the risk of dicoumerol formation in spoiled silage. Dicoumerol can interfere with the clotting ability of blood and results in excessive bleeding in animals if dicoumerol levels are high.

Red Clover

Red clover is adapted to the Black and Grey-wooded soil zones of Saskatchewan. It performs well in Grey Wooded and Black soil zones and is tolerant of soil acidity (pH 5.1).

Red clover is very difficult to ensile owing to its low water-soluble-carbohydrate content, combined with its very high buffering capacity and very high moisture content (see tables 5 and 6). Substantial wilting is necessary but is difficult to do without spoilage. Decayed leaves due to lodging or laying in swath for extended periods can introduce undesirable microorganisms into the silage.

Cutting red clover at the early bloom stage results in a crude protein content of 15-17 per cent. Harvesting at a later stage of maturity (i.e., full bloom) results in somewhat lower moisture levels but it also means that quality is lower.

Alsike clover has similar ensiling properties to red clover.

TABLE 7. Nutritive value of weeds and alfalfa

Crop	% Protein	Digestible Energy*
alfalfa	17.6	2.54
lamb's quarters	17.0	2.26
flixweed	15.6	2.17
kochia	15.4	1.76
stinkweed	15.2	1.86
wild oats	12.2	2.92

* mcal/kg dry matter

Miscellaneous Silage Crops

Almost any crop can be made into silage for livestock feed if it is palatable and contains enough nutrients and moisture to be properly ensiled. ***Hail damaged crops*** or crops that are too weedy and not economic to spray can be ensiled.

Hail damaged cereal crops should be treated in the same way as cereals grown for silage. The crop will make silage if the hail damage occurs before the hard dough stage and the crop has adequate moisture (60-70 per cent) to pack and ensile properly. If hail damage is severe, the quality of the silage will be low, as there will be fewer heads and leaves in comparison to stems, which are high in fibre and low in protein. Nitrates may also be a problem if the crop is made into silage after hail damage.

Canola can be used as a silage crop, although it is generally only used when it has been frozen or is too weedy to produce good seed yields. Canola silage has medium palatablility. If hail damaged, it should be ensiled as quickly as possible. Quality of canola silage can vary considerably, so any silage made from canola should have a feed test completed on it.

Precautions must be taken when using **weeds** for silage. Some weeds may not be palatable, may taint milk in dairy cows, or may be low in minerals. However, harvested in the green stage, most weeds make acceptable silage for livestock.

Kochia has been traditionally considered a weed because once established, it is very aggressive and difficult to control. It has advantages as a crop since it grows very well in saline soils and can yield in excess of 4 tons/acre (9 tonne/ha) of dry matter. Feed quality is good, with crude protein ranging from 13-18 per cent, although available calcium is not adequate to supply the needs of livestock. When feeding kochia, calcium needs to be added to their feed. (Oxalates in kochia tie up the calcium as calcium oxalate, which is unavailable.)

Since kochia grown on saline soils is very high in salts, livestock should have access to an ample water supply when being fed kochia. Salt levels may be high enough to cause scouring in livestock.

Kochia can also accumulate oxalate, nitrate and alkaloids. To avoid feeding problems due to these compounds, livestock rations should contain a maximum of 50 per cent kochia.

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